The Future of M&S in Navy Test & Evaluation

31 March 2004

Outline of Brief

- What DoD says about M&S in Acquisition
  - DODD 5000.1
  - DODI 5000.2
- What Navy proposes to say about M&S in Acquisition
  - SECNAVINST 5000.2C draft
- What People Are Saying (Urban Legends)
- 1998 NRC Study
- What some SIM Experts Say
- Where we are with M&S in T&E Today
- Role of M&S in Acquisition
- Challenges for M&S in Acquisition
- The Future of M&S in T&E
- Conclusion

The Defense Acquisition System

- DoDD 5000.1
  - Teaming among ... testers ... shall begin during capability needs definition (E1.2)
  - Test and evaluation shall be structured to ... assess attainment of technical performance parameters, and determine whether systems are operationally effective, suitable, survivable, and safe for intended use. (E1.11)
  - The conduct of test and evaluation, integrated with modeling and simulation, shall facilitate learning, assess technology maturity and interoperability, facilitate integration into fielded forces, and confirm performance against documented capability needs and adversary capabilities ... (E1.11)

Operation of the Defense Acquisition System

- DoDI 5000.2
  - Development and demonstration are aided by the use of simulation-based acquisition and test and evaluation integrated into an efficient continuum and guided by ... test and evaluation master plan (TEMP). (3.7.1.1)
  - System Demonstration. ... the use of modeling and simulation to demonstrate system integration are critical during this effort. (3.7.5)
  - The T&E strategy shall ... provide empirical data to validate models and simulations. (E5.1)

Operation of the Defense Acquisition System

- OT&E shall require more than an OA based exclusively on computer modeling, simulation, ... (E5.2)
- Projects (at) Milestone A ... shall have a T&E strategy (TES) that shall primarily address M&S ... (E5.3)
- The PM shall plan for M&S throughout the acquisition lifecycle. The PM shall identify and fund required M&S resources early in the life cycle. (E5.10)

SECNAVINST 5000.2C Draft

- When Modeling and Simulation (M&S) is part of the TES, the M&S proponent shall provide the strategy to comply with verification, validation and accreditation per reference (c). (5.3.1)
  - (Note reference (c) is SECNAVINST 5200.40, "Verification, Validation, and Accreditation (VV&A) of Models and Simulations," 19 Apr 99 (NOTAL)

- The TEMP shall identify anticipated use of M&S and the M&S proponent's verification, validation and accreditation (VV&A) strategy per reference (c). (5.4.7)

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- **5.4.7.9 <u>Modeling and Simulation (M&S)</u>**
  - Per reference (b), enclosure 5, M&S may be used during T&E of an ACAT program to represent conceptual systems that do not exist and existing systems that cannot be subjected to actual environments because of safety requirements or the limitations of resources and facilities. M&S applications include hardware/software/operator-in-the-loop simulators, land-based test facilities, threat system simulators, C4I systems integration environments/facilities, and other simulations as needed. M&S shall not replace the need for OT&E and will not be the primary evaluation methodology. M&S shall not be the only method of meeting independent OT&E for beyond low rate initial production (BLRIP) decisions per 10 USC 2399. (Note. Reference (b) is DoDD 5000.2)

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- **5.4.7.9 Continued .** M&S is a valid T&E tool that per reference (c) requires VV&A to supplement or augment test data. The PM is responsible for verification and validation (V&V) of M&S and the accreditation of M&S used for DT&E. The OTA is responsible for accreditation of M&S used for OT&E. The PM is required to complete V&V prior to an accreditation decision by the OTA. M&S previously accredited for other programs or test phases still requires accreditation for specific use by the OTA for each OT&E. Use of M&S shall be identified in Part III and Part IV of the TEMP for each DT&E and OT&E phase it is intended to support.

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- **5.4.7.9 Continued**. The PM shall identify and fund required M&S resources early in the acquisition life-cycle. The T&E WIPT shall develop and document a robust, comprehensive, and detailed evaluation strategy for the TEMP, using both simulation and test resources, as appropriate. See reference (b), enclosure 5, for implementation requirements for all DON ACAT programs.

What Some DoN People Are Saying (Urban Legends)

- M&S should be used to reduce the cost of T&E
  - M&S is cheaper than T&E
- “Live” T&E not required; M&S good enough
- Lots of Redundant Models, Let’s have just one
  - Save money
- Training M&S is the same as T&E M&S
  - Let’s combine them and save money

1998 NRC Study

- The use of simulation to augment operational test design and evaluation (and other related purposes such as to provide insight into data collection) has been strongly advocated by DoD officials. Although a number of workshops have been devoted to the use of simulation for assisting in the operational test and evaluation of defense systems, the precise extent to which simulation can be of assistance for various purposes, such as aiding in operational test design, or supplementing information for operational test evaluation, remains unclear. Great care is needed to ensure that the information provided by modeling and simulation is useful since the *uncritical* use of modeling and simulation could result in the advancement of ineffective or unreliable systems to full-rate production, or, conversely, the delay or return to development of good systems.

Simulation Based Acquisition (SBA)

- “IDA's research to date in physics-based M&S points to the likelihood that M&S can complement, not replace, Live Fire Tests. Such a conclusion would have a significant effect on the prospects for the DoD vision of Simulation-Based Acquisition (SBA), which has relied on ‘success stories’ such as the Boeing 777 and Dodge Intrepid to argue that SBA is achievable, and will either replace or significantly reduce testing in support of DoD weapon system acquisitions.”

And some SIM Experts Say

- 2003 Winter Sim Conference
  - "Models express opinions, not facts"
  - "A realization will emerge that the government should not expect to see the same results from simulation that General Motors or Boeing sees"
  - "Clearly, with most combat models, you tell the analyst the answer you want, and the analyst will get the model to give you that answer – with wholly justifiable values for input parameters."

More Sim Expert Testimony

- “Finding the optimal balance between hardware-based and M&S based testing requires a delicate balance of cost, schedule and risk”
- DoD M&S Types - … – just don’t practice rigor very well. … it is not uncommon to see papers published that have no literature surveys. … We don’t avail ourselves of peer review. We should.”

More Sim Expert Testimony

- “With this increased reliance on M&S in systems acquisition, VV&A of M&S becomes even more critical. While there have been considerable advances in M&S technology, there has been limited comprehensive research and review of VV&A methodology. Most VV&A is accomplished with Subject Matter Experts (SMEs) who review simulation predictions and test results, and provide a subjective opinion on the adequacy of the model. There are few examples of an objective process or quantitative criterion that allows the decision maker to fully understand why the model is or isn’t good enough for the particular application. Furthermore, in many instances, there is inadequate definition of the intended application of the model – a critical element in any accreditation.”

Some March 04 NDIA Comments

- Disappointed with long term results of M&S
- M&S not delivering all that's promised, will not give quantum improvements
- Over-reliance on M&S hurting DT&E

M&S Role in Acquisition

- Requirements Definition
  - Analysis of Alternatives (AoA)
- Design Development
  - AoA
- Analysis of Potential System Performance in areas where T&E unachievable
  - LFT&E
- Optimization of resource limited T&E
  - Refine Scope
  - Scenario Development
- Post T&E reanalysis of System Performance

Where we are with M&S in T&E Today

- M&S has not achieved the cost savings originally claimed
- M&S does not replace T&E
- M&S is needed, is complementary to and supports T&E
- There is no single M&S solution ... M&S models are optimized for different parameters dependent upon the users' needs
- M&S reuse potential is over-rated and very expensive
- M&S weakened by lack of robust Configuration Management (CM) and VV&A

Challenges for M&S in T&E

- Reduce Cost of CM and VV&A
- Continue physics-based model development
  - need better understanding of underlying physics
- Early involvement with programs and articulation of program M&S requirements in TEMP
- Ease program difficulty to survey existing M&S capabilities for potential use
- Dual use of simulators/stimulators for both T&E and Training
- Increase use of Hardware and Software in the Loop (HWIL/SWIL) in M&S for follow-on program increments/upgrades
- Getting sufficient Test data to validate model
- Improve model use in System-of-Systems analysis

The Future of M&S in T&E

- Evolutionary not revolutionary improvements over time
- Continued interest in development of physics based models
- Continued interest in the development of models and simulations that support both testing and training
  - Hardware and Operator in the Loop facilities
- Increased use of logistics predictive models to assess Suitability (e.g. Reliability) based upon small Test sample sizes
- Increased use of models to optimize resource constrained testing

Conclusion

- OPNAV N091/N912 (Navy Test & Evaluation Division)
  - Policy shop for T&E M&S questions/issues
  - Looking for models and simulations that can support acquisition

- Questions?